Evaluation of the Use of Electricity for Predator Removal at the Tracy Fish Collection Facility

Investigators

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Summary

Federal and state fish screening facilities in the south Sacramento-San Joaquin Delta have been known to provide favorable habitat for predator fish, primarily striped bass *Morone saxatilis* (Gingras 1997, Bark *et al*. 2009). Predators tend to concentrate in and around fish screening facilities in zones where water velocities are lower (Bark *et al.* 2009*)*. At the Tracy Fish Collection Facility (TFCF), striped bass are frequently found residing upstream, downstream, and within the facility (Bark *et al.* 2009*)*. Striped bass are piscivorous fish that consume smaller fish and can reside within the TFCF year round feeding on seasonal influxes of entrained fish. Thus, striped bass can sustain a viable population within and near the facility as long as they have favorable environmental and feeding conditions (Bark *et al.* 2009*)*. According to the Reasonable and Prudent Alternative in the 2009 National Marine Fisheries Service Biological Opinion, by December 31, 2011, Reclamation shall complete studies to determine methods for removal of predators in the primary channel, using physical and non-physical removal methods (*e.g.*, electricity, sound, light, CO_2), leading to the primary louver screens with the goal of reducing predation loss to 10% or less.

At the TFCF, the louvers in the primary channel guide fish to one of four 6-inch-wide primary bypasses. The bypasses transition into pipes which carry the fish and flow into a secondary channel. A secondary set of louvers guide fish through another fish bypass and into the holding tank area. Predator fish removal is conducted periodically by lowering the secondary channel water level and manually removing predators. High flows are released through the fish bypasses to force predators out of the bypass pipes where they can be netted and removed. Predator removal is more difficult in the primary channel due to the larger channel width and water depths and the inability to dewater the channel. Gill nets and hook-and-line are the current options for predator removal in the primary channel.

The goal of this study is to investigate the potential for using electricity as a safe and effective way of deterring or preventing large predator fish from taking up residency in the primary channel of the TFCF. Electric fish barriers are typically produced by submerging two or more metal electrodes in a fixed location and applying a voltage between them. An electrical current passes between the electrodes, forming an electrical field in the water. Fish in contact with the electrical field can experience a reaction from a slight twitch to full paralysis, depending on the voltage level and duration. Electric fish barriers are commercially available, but only limited testing has been conducted to document the effectiveness of electric fields as a behavioral barrier. Reclamation's experience indicates that electric fields may be a potential deterrent in flowing waters (Sechrist and Hiebert, in progress). Past field experience has shown that fish guidance with electric fields is poor in downstream situations, particularly for small fish. Good results were seen in moving larger fish greater than 150 mm (6 in) away from immediate contact with electrodes.

In FY 2010, a small-scale laboratory tank was tested to measure the amount of power transfer required to affect striped bass in the size range of 250–370 mm (9.8–14.6 in) TL with a water conductivity of 0.4 mS/cm. Flat-plate electrodes were affixed to the ends of the tank and a uniform voltage gradient was applied through the tank using a Smith-Root generator-powered pulsator unit GPP 9.0. The waveform of the pulsed DC signal was observed with an oscilloscope and the voltage gradient was measured with a gradient meter. Response levels from twitch to taxis to tetanus were observed and documented during the experiments. In order to determine whether there is any impact on smaller-bodied fish when power levels that affect striped bass are applied, a smaller size fish of about 100 mm such as threadfin shad or rainbow trout will also be tested in the laboratory tank in FY 2010. Results of the tank experiments will be documented for incorporation into a more comprehensive report after the study is complete.

In FY 2010, a full analysis of potential installation locations for electricity at the TFCF will be completed. Potential applications of the use of electricity include:

- Manned boat electrofishing
- Fixed electric barrier upstream of trashrack
- Electric barriers on end of bypass pipes to prevent predators from swimming upstream during secondary channel predator removals
- Fixed pulsed electric crowder throughout the primary channel.
- Fixed localized electrode installation along the right primary channel sidewall or downstream of the trashrack piers
- Application of automated harvesting techniques

Many options can be excluded due to personnel or public safety concerns or logistical constraints. The most reasonable possibilities for the use of electricity are automated harvesting to collect fish in a retractable net or a localized electrode installation along the right sidewall to move predators into the fourth bypass so that they can be collected in the secondary system or holding tanks. In order to determine how fish will respond to electricity in moving water, an experiment in an oval recirculating flume at the TFCF will be conducted in early FY 2011. If results from the recirculating flume

are favorable, a small-scale experiment in the primary channel is also recommended for FY 2011.

Problem Statement

The objective of this study is to determine whether the use of electricity as a predator removal technique is viable at the TFCF. In FY 2011, researchers will evaluate the response of large predators and smaller-bodied fish in moving water when certain voltage gradients determined in the laboratory are applied. If the predators exhibit a taxis response in moving water when an electric field is present and small-bodied fish do not appear to be affected, a small-scale experiment using automated harvesting in the primary channel will be conducted. If the predators are immobilized and swept downstream in moving water and small-bodied fish do not appear to be affected, an experiment using a fixed localized electrode installation will be conducted.

Goals and Hypotheses

Goals:

1. Determine how water flowing in the velocity range of 1–3 ft/s affects large- and small-bodied fish exposed to electric fields.
2. Determine if large-bodied fish exhibit a taxis response as they do in stationary water or if they sweep downstream by the current.
3. If large-bodied fish are swept downstream, determine if they remain inhibited long enough to move through a bypass intake.
4. Determine if an automated harvesting device or a fixed localized electrode installation can be designed to safely and effectively remove or deter predator fish at the TFCF.

Null Hypotheses

1. Large-bodied fish will not exhibit a taxis response when velocities are less than 2 ft/s. Large-bodied fish will not be swept downstream when velocities are greater than 2 ft/s.
2. Fixed, localized sets of electrodes are not the most viable alternative for impacting predator residency at the TFCF.
3. The electric field will not be skewed by metal facility components near the test installation.

Materials and Methods

The next step in this study is to determine how moving water affects the response of striped bass in the size range of 250–370 mm (9.8–14.6 in) TL to previously tested electric power levels. An oval-shaped flume located at the TFCF is equipped with a recirculating pump. Since the flume can be filled with Delta water and test fish are readily available at the facility, the experiment will be conducted at the TFCF in the fall of 2010. A backpack electrofisher unit will be used to produce the amount of electrical power that affected striped bass in the laboratory experiments. A field voltage gradient meter will be used to measure the voltage gradient applied to the water. The temperature and conductivity of the water will be measured before each experiment. The recirculating flume will be set to velocities of 45.7, 61.0, 76.2, 91.4, and 106.7 cm/s (1.5,

2.0, 2.5, 3.0, and 3.5 ft/s) and the response of striped bass and a small-bodied fish (species to be determined by availability) will be documented. An additional recirculating pump may need to be purchased if higher velocities cannot be obtained with the existing pump. It is anticipated that five fish will be tested at each velocity to bracket variability due to the size and condition of the fish.

If small-bodied fish are affected by the electrical field, researchers will need to discuss whether or not this study should continue to a small-scale installation. If small fish are not affected and results for large-bodied fish appear favorable, it is recommended that this concept be pursued in a small-scale installation in the primary channel.

If striped bass exhibit a taxis response in moving water when an electric field is present, a small-scale experiment using automated harvesting in the primary channel will be designed. Fish are physiologically attracted to the anode of electrical field when a DC field is present. Hanging chains, electrified seines, or other devices can be used to force swimming toward the anode when a voltage is applied. The fish can then be collected with an automated net and removed. If this alternative appears to be the most viable, more research on automated harvesting materials and techniques will need to be conducted prior to field evaluation.

If predators are swept downstream in moving water, an experiment using a fixed localized electrode installation will be designed. Since most fish pass through the final fish bypass at the TFCF (Bates *et al*. 1960), this may be a region where a fixed electric field can be applied. Predators would be forced into the fourth bypass intake and collected in the secondary system or the holding tanks. Before these experiments can be designed, Smith-Root, Inc., will be contacted to discuss potential shapes and sizes of electrodes (such as long rounded metal poles) and other required equipment for the location selected.

In either field application, safety must be a priority. Smith-Root, Inc., will be contacted regarding safety precautions and procedures. The researchers will determine the distance that the electric field extends from the source as well as the potential for electrification of the metal handrails and other metal facility components. If the field experiments cannot be conducted safely, they will not be conducted.

Coordination and Collaboration

Aquatic scientists and hydraulic engineers from the Denver Technical Service Center will coordinate with TFCF staff before and during field research. Researchers will contact Smith-Root, Inc., regarding the design of a field installation. A Job Hazard Analysis (JHA) will need to be completed before any testing with electricity at the facility commences. The JHA will include the necessary safety equipment and procedures for working near electrical fields in water. Biological and operational staff at the TFCF must be informed of testing times and safety procedures. The test fish required for the oval tank experiments will be requested through Brent Bridges.

Endangered Species Concerns

Results from the laboratory tank test and the recirculating flume test will show whether small-bodied fish are affected by the electrical field required to affect the behavior of striped bass. These results will guide the decision on whether to employ a small-scale installation in the primary channel. If a field installation is conducted,

incidental "take" of ESA listed salmon, steelhead, and delta smelt is possible. These fish will be returned to Delta waters as quickly as possible. The total number of each ESA species incidentally caught or collected during the experiment will be recorded and sent to the reporting agencies. The incidental take from this research is covered under the TFCF Section 10 permit.

Dissemination of Results (Deliverables and Outcomes)

Investigators will produce a volume in the peer reviewed Tracy Technical Report Series as the expected deliverable from these experiments. The report will include results of the stationary laboratory tests, results of the moving water recirculating tank tests, an analysis of potential installation locations for electricity, and results of a small-scale field installation (if conducted). We also anticipate presenting our findings at a Tracy Technical Advisory Team (TTAT) meeting.

Literature Cited

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